

Citation for published version:

Gibbs, DJ, Emmitt, S, Lord, W & Ruikar, K 2015, 'BIM and construction contracts: CPC 2013's approach', *Proceedings of the ICE - Management, Procurement & Law*, vol. 168, no. 6, pp. 285-293.
<https://doi.org/10.1680/jmapl.14.00045>

DOI:

[10.1680/jmapl.14.00045](https://doi.org/10.1680/jmapl.14.00045)

Publication date:

2015

Document Version

Publisher's PDF, also known as Version of record

[Link to publication](#)

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BIM and construction contracts – CPC 2013's approach

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Building information modelling (BIM) changes the way information is generated, managed and communicated between project team members. It is gaining international attention as a potential way of improving the efficiency of the construction industry; but despite the recognised benefits of BIM, perceived barriers are restricting its adoption. Some of these barriers could be addressed through standard forms of construction contract. The Chartered Institute of Building's *Complex Projects Contract 2013* (CPC 2013) is the first standard form of construction contract to include BIM clauses in its provisions and appendices. To investigate how CPC 2013 attempts to address the perceived barriers of BIM adoption and promote working in a BIM environment, a content analysis was undertaken. The research found that although CPC 2013 addresses some of the perceived barriers associated with BIM, the contract may require amendments and special conditions to its standard form in order to support a 'Level 2' environment.

1. Introduction

Over 75% of construction organisations around the world have an underperforming project (KPMG, 2013). This can be attributed to quality issues, cost overruns and longer project durations which could develop into disputes if they are not resolved (Kumaraswamy, 1997).

Disputes are becoming increasingly likely on construction projects (Cheung and Pang, 2013; NBS, 2013b) but they have a negative effect on the industry. The global average construction dispute is valued at US\$31.7 million, lasts 12.8 months (EC Harris, 2013) and generates indirect costs of lost productivity, stress and fatigue, loss of future work, reduced profit, and tarnished reputation (Love *et al.*, 2010). Furthermore, skill sets outside of the construction industry are employed to resolve the dispute which results in money migrating to other sectors.

Disputes can arise out of the construction industry's inefficiencies but, despite the publication of numerous documents which acknowledged the sector's waste, there has been little improvement (CIOB, 2008; Egan, 1998; Latham, 1994; NAO, 2001; Wolstenholme *et al.*, 2009). In an attempt to bring about positive change, the UK has defined a set of strategy objectives (Cabinet Office, 2011); one of which is building information modelling (BIM).

BIM has gained international recognition as a way of improving efficiency (McGraw Hill, 2014a) and reducing the number of delays and disputes in the construction industry (BSI, 2013). However, it can be argued that the uptake of BIM has been limited by perceived barriers to its adoption (Eastman *et al.*, 2011), some of which could be overcome through a construction contract.

The CIOB's *Complex Projects Contract 2013* (CPC 2013) is the first standard form of construction contract to include BIM in its clauses and appendices (CIOB, 2013). Like the UK Government, CPC 2013 recognises the inefficiencies of the construction industry and acknowledges the potential of BIM to make a step change.

There is little published research investigating the incorporation of BIM into standard forms of construction contract and, as a relatively new contract, there is a limited amount of independently published research on CPC 2013. Therefore, the objective of this paper is to add an original contribution of knowledge by investigating how CPC 2013 attempts to facilitate a BIM environment. This is achieved through a content analysis.

2. Background

2.1 Building information modelling (BIM)

There is a plethora of inconsistent BIM literature available which has led to the term BIM meaning different things, to different people, around the world (NBS, 2013a). In order to establish consistent terminology, this paper is written in relation to the UK's perspective of BIM.

As one of the leaders in the development of BIM (HMG, 2012), the UK has produced numerous documents to support their Government's mandate of a 'fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016' (Cabinet Office, 2011). This is commonly referred to as Level 2.

Level 2 advances past unmanaged computer-aided design (CAD) (Level 0) and managed CAD, which may include three-dimensional

(3D) design (Level 1) (GCCG, 2011). Instead, Level 2 focuses on collaborative working and requires each project team member to create a virtual 3D model of their work using object-oriented software and to follow a managed approach to information creation and exchange.

Object-oriented software is more developed than traditional CAD and uses 'smart' objects which interact with each other through their individual properties and awareness of space (Eastman *et al.*, 2011). The 'smart' objects represent physical components and allow information to be embedded or linked to each item. This opens up the opportunity for multiple dimensions (*nD*) (Ding *et al.*, 2014) which could include the construction programme (4D), cost information (5D) and facilities management information (6D) (RIBA, 2012). These multiple dimensions are distinctly different from the various levels and although they can be utilised in a Level 2 environment, they are not a minimum requirement under the UK's mandate. But, regardless of whether multiple dimensions are used or not, a mass of data is likely to be generated within a Level 2 environment and is required to be managed.

Under Level 2, each project team member is required to deliver a certain Level of Development (LoD) at specified stages of the project (AIA, 2008; BIM Forum, 2013; BSI, 2013; NATSPEC, 2013). At each specified stage, individual models can be brought together by a coordinator to create a 'federated model'. To facilitate the input, management and exchange of this data, a Common Data Environment (CDE) is required which will act as a single point of reference for all project information (BSI, 2014b).

The stages after Level 2 are not well established. It is likely that Level 3 and beyond will involve 'Open Data' standards, new contractual frameworks, development of a new culture, training and growth (HMG, 2015). This collaborative process could be developed to include interoperability for smart cities, nano-second procurement and performance, and robotics and autonomous systems (CIC, 2014).

Some organisations may confuse levels or undertake aspects of each level. This can create situations such as 'lonely BIM', where an organisation does not collaborate and uses elements of BIM for the sole benefit of their business (Das *et al.*, 2014; McGraw Hill, 2012).

2.1.1 Benefits of Level 2 BIM

The benefits associated with Level 2 BIM are far-reaching and well-documented and they can be summarised as (BD, 2014; McGraw Hill, 2014a)

- better collaboration and improved team relationships
- ease of access to project/asset information
- easier analysis of the ongoing project/asset
- concepts are easier to realise and alternatives easier to formulate
- improved workflow cycle time and reduced waste (double working)

- reduced lifecycle cost and schedule growth as well as improved certainty
- more sustainable construction and green performance of the asset.

However, despite these benefits, perceived barriers to Level 2 adoption exist (Eastman *et al.*, 2011).

2.1.2 Perceived barriers to BIM adoption

2.1.2.1 LEGAL AND CONTRACTUAL

Although little is expected to change in terms of copyright law, contracts and insurance within a Level 2 environment (GCCG, 2011), it can be argued that BIM alters relationships and blurs the lines of the roles and responsibility of project team members so it could affect the current legal and contractual position (Harris, 2012). This has generated uncertainty (Currie, 2014) and has led to promoters and participants asking the following questions (Joyce and Houghton, 2014).

- Who owns the federated model?
- Who is responsible for creating, analysing and updating project information, including the federated model?
- When will information be delivered and how much can it be relied upon?
- What is the priority of documents?

2.1.2.2 COLLABORATION

BIM is a collaborative way of working (HMG, 2012) so, it requires (Barratt, 2004)

- a collaborative culture
- external and internal trust and mutuality
- information exchange
- technology and tools
- process integration; and
- strategic planning.

Collaboration can improve project performance (Greenwood and Wu, 2012) but it can face various forms of resistance (Wilkinson, 2005). This can result in some individuals and project teams becoming focused on 'silo' working which, in some cases, can develop into an adversarial attitude towards business. Therefore, the sharing of power required to support a collaborative environment could be difficult for some to accept (Emmitt, 2010).

Furthermore, the development of technologies and tools to support collaborative working face unique demands (Grudin, 1994). This includes interoperability issues between different software platforms, which are estimated to cost the United States capital facilities industry around US\$15.8 billion per year in addition to significant inefficiency and lost opportunity costs (NIST, 2004). Interoperable software is a fundamental component of Level 2, especially for the exchange of graphical models and although attempts have been made to solve this issue through the development of neutral, open, platforms for graphical model exchange, such as Industry

Foundation Classes (IFC) (Eastman *et al.*, 2010), there remains a lack of confidence within the construction industry (Jeong *et al.*, 2009; Lockley *et al.*, 2013; Sacks *et al.*, 2010).

2.1.2.3 USE AND MANAGEMENT OF INFORMATION

The construction industry has been slow to embrace the use of electronic information, particularly for site management activities (Davies and Harty, 2013) and even when electronic information is used, it is not always well managed (CIOB, 2008), which can make its retrieval challenging (Joia, 1998).

Within a Level 2 environment, project team members are expected to generate and exchange information in electronic format. Paper documentation is limited and a 3D virtual model is required. This may not be common practice for some of the project team. Given the enhanced speed in which information can be exchanged and the mass of data data could be generated in a Level 2 environment, the problems associated with electronic information exchange could be exacerbated. Additionally, the interface between project team members might challenge the segregation of conventional procurement. Therefore, the release of information might not be governed by what is 'reasonable' and the improved transparency of information can bring the responsibility to warn project team members of the potential impact of any changes (Mosey, 2014).

2.1.2.4 INVESTMENT

BIM, as a process, is supported by software, hardware and which require the investment of time and money. The purchasing, maintenance and upgrading of software that has been developed to support BIM tends to be more expensive than conventional CAD packages (Stowe *et al.*, 2014). Furthermore, the minimum hardware requirements to support this software may not be available on standard computers and training will be required to operate the new hardware and software, as well as to understand the new process of working.

2.1.3 Addressing the perceived barriers

2.1.3.1 KEY DOCUMENTS AND PROCESSES

Following the UK BIM mandate, various documents have been published to support Level 2 adoption by addressing some of the perceived barriers. These documents include

1. *CIC BIM Protocol* (CIC, 2013)
2. PAS 1192-2: 2013 (BSI, 2013)
3. PAS 1192-3: 2014 (BSI, 2014b)
4. BS 1192-4: 2014 (BSI, 2014a).

Additional publications are expected, which include a specification for BIM security along with refinement of the BIM toolkit. These documents are intended to be used in conjunction with existing recommended practice and have been designed for use with all contract forms.

2.3.1.2 STANDARD FORMS OF CONTRACT

Although little change is required for standard forms of construction contract to support Level 2 adoption (GCCG, 2011), it is not

common for BIM to be referenced or adopted in contracts (NBS, 2013b). The Joint Contract Tribunal (JCT) and the New Engineering Contract (NEC) suites of contracts are two of the most commonly used standard forms of construction contract (NBS, 2013b; RICS, 2011) and attempts have been made to make them Level 2 compatible.

The NEC published *How to use BIM with NEC3 Contracts* (NEC3, 2013) which focuses on the creation of the 'model'. The guide advises on how the CIC BIM protocol can be incorporated into some of NEC3's contract forms and offers guidance on inserting technical requirements into the contract, as well as addressing the project team members' rights and liabilities through additional conditions of contract ('Z' clauses).

JCT have published a public sector supplement which suggests steps and modifications to be made when design work and information exchange is governed by a BIM protocol (JCT, 2011). The document consists of schedules of modifications for a variety of JCT contracts and sub-contracts, one of which is the Constructing Excellence Contract which encourages collaborative working (Frame, 2012).

Despite the popularity of the NEC3 and JCT suite of contracts in conventional construction projects, PPC 2000 was the contract chosen for the UK government's Level 2 BIM trial projects. The multi-party contract was favoured as it governs the duration of the procurement process and promotes collaboration by bringing in key project participants at the design phase of the project (Tyerman, 2013). On the trial projects, no amendments were made to the contract in respect of BIM; neither was a BIM protocol used. Instead, a set of mutual intellectual property licences were created, linking a series of deadlines to the contract under PPC 2000's multi-party structure (Mosey, 2014).

However, in their current standard form, these contracts do not include reference to BIM in their clauses and appendices. The first standard form of contract to do this is CPC 2013.

2.2 CPC 2013

CPC 2013 is designed for international building and construction projects which cannot be managed by intuition alone. A variety of procurement methods can be used under the one form of contract along with the option of using special conditions for each project (Pickavance, 2014).

The contract was developed to address research which reported that over 60% of complex projects were not delivered on time or within budget and that inadequate progress records were kept for their management (CIOB, 2008). Therefore, unlike other forms of construction contract, CPC 2013 is prescriptive on programming, resource data and record keeping in relation to recommended best practice (CIOB, 2011). The aim of this proactive, open, scientific approach is to reduce the likelihood and severity of disputes (Fenwick Elliott, 2014).

To facilitate this, the contract utilises twenty-first-century methods of working. No paper documents are required for communication and the contract focuses on collaboration and transparency of information in order to manage risk, time, cost and quality. To administer this, the contract includes new roles such as the project time manager and data security manager.

The contract is designed to work on both BIM and conventional projects. While other standard forms of contract require amendments for Level 2 use, CPC 2013 includes BIM in its clauses and appendices which are supported through the incorporation of a BIM protocol.

3. Methodology

As a relatively new contract, there is little peer reviewed literature or project data associated with CPC 2013. Publications which analyse how other standard forms of construction contract overcome key issues have undertaken a content analysis (Patterson and Trebes, 2013) which is a flexible research method to analyse text data and make inferences from communications in relation to the context of their use (Krippendorff, 2010).

Content analysis can be criticised for focusing attention and bias; however, this research maintains that it is an appropriate methodology for analysing construction contracts and a directed approach was used (Hsieh and Shannon, 2005). This involved a structured process, which reviewed the literature to identify the perceived barriers associated with BIM adoption. These findings were used as a framework against which the clauses and appendices of CPC 2013 were analysed. This same structure was then used to guide the discussion of the findings.

4. Analysis

4.1 Legal and contractual

Under CPC 2013, copyright and ownership rights remain vested in the creator, with particular reference to the contractor. If a contractor is required to contribute to a model and/or federated model, or if the contractor is required to design the whole works, the contribution, and information derived from its input, remains the copyright of the contractor [CPC 2013 Clauses 11.2 and 11.3]. Licences and sub-licences are to be granted to allow the use of this information for its permitted purpose [CPC 2013 Clause 11.1.2] and the employer can use the contractor's design for certain purposes [CPC 2013 Clause 10.2.3]. To ensure commercially or security sensitive information is not made available to those who should not have access [CPC 2013 Clause 21], a data security manager is employed [CPC 2013 Clause 11.4].

An overview of the project team member's roles and responsibilities are provided in the contract's user notes [CPC 2013 User Notes, pp. 42–46] and additional listed persons can be included in the contract [CPC 2013 Appendix B: Listed Persons]. The responsibility of creating, analysing and updating project information to a required standard, at a set delivery period, are

set out in the contract [CPC 2013 Appendix C]. The works are split into six design stages, with a particular LoD required at each stage [CPC 2013 Appendix C: Table 1]. The model is to be used only for the design stage for which it was intended [CPC 2013 Appendix C: C1] and the design contributor for each design element, which is referenced to Uniclass (CPIC, 1997), is assigned to each stage of the project [CPC 2013 Appendix C: Table 2]. The models can be brought together to create a federated model and maintenance of the federated model is to be undertaken by a design coordination manager [CPC 2013 User Notes, pp. 44 and 72].

The priority of documents is established in the contract, with preference given to the federated model and the information derived from it over the use of technical drawings [CPC 2013 Clause 3.3]. A BIM protocol is required for the maintenance of the model under the contract [CPC 2013 Clauses 11.1.4 and 11.3.3]; however, if there is a difference between the contract and the protocol, the contract will prevail unless stated in the contract's special conditions [CPC 2013 Clause 11.4].

4.2 Collaboration

CPC 2013 introduces itself as a contract which promotes the use of technology and requires a collaborative, transparent, approach to working which is hoped to assist the delivery of the project within time and budget [CPC 2013 Conditions: Introduction]. A collaborative environment is created through the conditions of the contract under which the project teams have a clear purpose and are required to co-operate in a spirit of mutual trust and fairness [CPC 2013 Clause 5.1].

The use of collaborative software, particularly a CDE which allows project team members to exchange electronic information through a web-based server, is promoted in CPC 2013; however, other means of information exchange are allowed under the contract [CPC 2013 Clause 2.4.7]. Documents and information are to be exchanged in native file format and the software, hardware and data associated with the information exchange platform are to be updated and maintained by the party identified in the special conditions [CPC 2013 Clause 5.15].

The working schedule and progress records require the software and its version to be stated [CPC 2013 Appendix D1 and E2]. If BIM is adopted on the project, whereby the contractor designs the whole works, the contractor is responsible for the suitability and integrity of the selected software and all information extracted from the model [CPC 2013 Clause 11.3.4].

4.3 Use and management of information

CPC 2013 acknowledges twenty-first-century ways of working [CPC 2013 Conditions: Introduction] and does not require any information to be printed and delivered in hard copy format alone [CPC 2013 User Notes, p. 47]. Instead, the contract promotes the exchange of electronic information, preferably through a CDE, which is to be shared in native file format to assist with information transparency [CPC 2013 Clause 2.4.7].

Information is to be managed and published through the chosen information exchange platform [CPC 2013 Clause 2.4.7]. If the contractor fails to publish information at a required time, a procedure has to be followed [CPC 2013 User Notes: Flow Chart No.1 – Failure to Publish, p. 83], which could result in an external party being employed to create the required information at the cost of the contractor [CPC 2013 Clause 25.2].

If the project adopts BIM, the model is to be developed in accordance with Appendix C [CPC 2013 Appendix C: Table 1 and 2] and the same coding structure is to be used for the working schedule and the model [CPC 2013 Appendix D: Paragraph D9]. The model and information derived from it have preference over conventional construction documents [CPC 2013 Clauses 3.3 and 3.4.1] and if any project team member becomes aware of an event which could interfere with the project, they are to issue an early warning [CPC 2013 Clause 36].

4.4 Investment

Although not a contract requirement, CPC 2013 suggests that the purchase, installation and training in software and hardware required to fulfil the conditions of the contract should be borne by the organisation using them as these items add value to the investing organisation after the project is complete [CPC 2013 User Notes, p. 39].

5. Discussion

5.1 Similarities between CPC 2013 and BIM

While undertaking the content analysis, similarities between CPC 2013 and BIM emerged (Gibbs, 2013). Both CPC 2013 and BIM

- require transparent, reliable, electronic information exchange
- aim to produce high value project information which can be used to make informed decisions and increase certainty for project team members
- require front end investment in an attempt to reduce the likelihood and severity of future problems
- require a collaborative approach.

As a consequence, a synergy between the two exist and even without specific reference to BIM, CPC 2013 creates an environment which goes some way to address the perceived barriers of BIM adoption.

5.2 Addressing the barriers

5.2.1 Legal and contractual

Within a Level 2 environment, project team members are required to work in isolation to produce information. In terms of output, apart from the individual 3D virtual models, it could be argued that little changes from conventional practice. Therefore, CPC 2013's approach of allowing the creator to retain ownership and grant licences to others for their use appears feasible. However, given that CPC 2013 is a two-party contract between the client and the contractor, the application of these terms only relates to the

contractor and would need to be expanded into other forms of contract to encompass all project teams.

The roles and responsibilities of each project team member are described in the contract's user notes and a matrix is used to assign project team members the responsibility of creating, analysing and updating specific project information at different stages of the project. The contract explicitly states that this information should only be used for the design stage in which it was intended. However, it could be argued that the matrix is not adequate for this purpose and that the contract is reliant on the BIM Protocol to specify how the model and/or federated model should be maintained. Nevertheless, the use of matrices for the purpose of assigning responsibility is consistent with other key BIM documents. Although they may not be directly compatible because CPC 2013 uses different LoD and design stages, the contract does allow the matrix to be replaced or modified to suit the project [CPC 2013 Appendix C: Footnote 6]. Therefore, care should be taken to ensure consistency between documents.

Given the masses of data involved in a Level 2 environment and the level of transparency required under the contract, the creation of the data security manager is useful for the successful management and security of project information. In the event the models are federated and changes are made, the software should be capable of identifying what change has been made and who made it.

Conflicts between terminology and priority of documents may occur between the contract and the selected protocol. Whereas CPC 2013 states that the terms of the contract shall prevail over a BIM protocol, the CIC BIM Protocol (2013) states that the protocol will prevail over other contract documents [CIC BIM Protocol: Clause 2.1]. Therefore, amendments may be required to the documents.

5.2.2 Collaboration

CPC 2013's definition of BIM focuses on the term 'model' and not collaboration; however, the requirements of a collaborative culture and trust are set out in the introduction of CPC 2013's user notes and under the obligations of the parties. The wording used in Clause 5.1 is comparable to clauses found in other standard forms of contract and, although similar clauses have been acknowledged by the courts [*Northern Ireland Housing Executive v. Healthy Buildings (Ireland) Ltd* [2014] NICA 27], the impact of such a provision on the other clauses in a contract is unclear (Barlow, 2011). Therefore, it is uncertain whether Clause 5.1 alone can enforce aspects of collaborative working. Recognising this, CPC 2013 attempts to reinforce the idea of collaboration by setting a collective goal and promoting openness through prescriptive contract requirements. Nevertheless, the contract cannot instantly change the nature or culture of construction works; neither can it change some of the ingrained attitudes towards collaboration. Therefore, adversarial behaviour could still remain under the contract and restrict collaboration.

Although not only native files are required to be exchanged, the requirement for information to be produced and shared in electronic

format, along with the native file, should encourage collaboration and improve trust as project team members have the opportunity to interrogate information in the format it was created. However, to realise this benefit, the appropriate software to open the file is required. Given the variety of specialist software which has been developed to support BIM, it is unlikely that software licences will be held by all of the project team members (McGraw Hill, 2014b), so access to native files may not be of assistance.

Furthermore, the specification of software requirements only applies to the working schedule and progress records. While this requirement goes some way to improve interoperability issues, the problems associated with interoperability are far reaching and are likely to exist between other forms of information exchange, most notably the virtual model. Unless this is addressed in the appropriate protocol, collaboration could be inhibited.

A platform for collaborative information exchange is provided through the CDE. The contract's defined process for managing and using information allows the CDE to be used for shared understanding between project team members and can be effective if it is used correctly. However, the use of a CDE is not compulsory under CPC 2013 and the alternative options, file transfer protocol or email, might not support collaboration on complex projects as effectively.

Although the prescriptive nature of CPC 2013 drives the project team towards a common goal and ensures that recommended practice is upheld, it does provoke debate as to whether the contract trusts individuals and organisations to perform their roles. The contract also recognises the adversarial nature of the construction industry and establishes a procedure to reduce the frequency and severity of disputes. While some may take the stance that CPC 2013 is expecting the collaborative environment to fail, others will acknowledge that conflicts are a natural part of the construction process and see value in a precautionary, defined, dispute resolution process.

5.2.3 Use and management of information

CPC 2013's promotion of electronic information and its preference to use a CDE to manage project information provides a suitable foundation for a Level 2 environment. If used correctly, a CDE will assist with managing the high volume of data which is likely to be produced in Level 2 projects. However, the contract does not enforce the use of a CDE and allows the use of alternative options for information distribution. This could include file transfer and email, which might not efficiently manage high levels of data.

The LoD and design author responsibility matrices assist with the production and management of information and the contract's failure to publish procedure should encourage the accurate production and reliable delivery of information. However, this process relies on the project stages being well established and understood by all project team members. Furthermore, CPC 2013 uses Uniclass as its classification system, which may not be favoured by some project

team members, especially since Uniclass 2 was published to support BIM adoption (Monteiro *et al.*, 2014).

Given the need for collaboration and transparent information, it is likely that project team members will realise events which could have a negative impact on the project. The system of providing early warnings is a useful and well-established way of doing this.

Although the 3D virtual model is intended to be an accurate representation of the works, object-orientated software cannot always produce the detail required, so the creation of additional information may be necessary. The contract acknowledges this, stating that the federated model should be used where applicable, but this could be left open to interpretation.

Some of the documents that have been published by the UK to support their BIM mandate offer guidance on the use and management of information throughout the lifecycle of a BIM project. As CPC 2013 was released before the publication of various key documents, there is no reference to these publications in the contract. However, the use of these documents is encouraged in some protocols and they could be made an explicit contractual requirement.

5.2.4 Investment

The contract does not explicitly state who should pay for investment. Although CPC 2013 suggests that the cost of software, technology and training should be borne by the organisation using them, some may argue that multiple sources benefit from the investment; therefore, it should be a project cost.

5.3 The future of BIM and its application with construction contracts

Aspects of technology are developing at an exponential rate. Some developments will be made to address specific construction problems, whereas the technological developments in other sectors may have a transferable benefit to the construction industry. Therefore, the move towards electronic information exchange and 3D virtual modelling, as required in a Level 2 environment, should see the amount of technology applied on construction projects increase.

Current developments, such as the use of handheld devices for contemporaneous record keeping (Davies and Harty, 2013) and the use of the virtual model to support time management and analysis (Gibbs *et al.*, 2014), could assist with the requirements of CPC 2013 and other construction contracts. However, if the use of technology starts to alter the legal position and relationships between project team members, the contract and supporting information may not be appropriate. Therefore, any advance past Level 2 will require further consideration.

6. Conclusion

CPC 2013 goes some way to facilitate BIM adoption by attempting to overcome the perceived barriers associated with working in

a Level 2 environment. Like NEC3 and JCT, CPC 2013 requires a BIM Protocol to be incorporated into the contract. In standard form, the NEC3 and JCT suite of contracts do not reference BIM, but CPC 2013 makes the incorporation of a BIM protocol mandatory and references BIM in its clauses and appendices. This could provide project team members with the confidence they require to adopt BIM.

However, in its standard form, CPC 2013 may not facilitate a true Level 2 environment and the inclusion of special conditions and amendments to the contract and protocol might be required. Such amendments may not be required under PPC 2000. As all of the standard forms of contract are only compatible with Level 2 working, care should be taken if project team members wish to advance past this level.

In contrast to the other standard forms of contract, CPC 2013 is prescriptive in nature, which helps encourage openness of information and drives the project teams towards a common goal. This could help facilitate collaborative working, which forms the foundation of BIM. However, CPC 2013 appears to have suffered from a release date prior to the UK's publication of key documents to support BIM and as a consequence, key documents are not present in the contract. Furthermore, CPC 2013 appears to focus on BIM as a virtual model, instead of as a collaborative process of working, with emphasis on the construction stage more so than the lifecycle of the built asset. Although the contract clauses attempt to support collaboration and the process of structured electronic information exchange, it could be argued that CPC 2013 facilitates a Lonely BIM environment as the contract only exists between the client and the contractor. Other standard forms of contract could be employed between the client and other project team members to establish a Level 2 environment, but inconsistencies may occur and the legal framework could become difficult to manage. Therefore, there would be value in drafting additional contracts which are consistent with CPC 2013 and could exist between the client and other project team members.

There is little research investigating how standard forms of construction contract attempt to establish a Level 2 environment and little published research specifically on CPC 2013. It is hoped that this research will act as a platform for further investigation and discussion which could investigate and compare how other standard forms of construction contract facilitate a BIM environment. Further investigation is also required to understand the amendments and additions required for CPC 2013, and other standard forms of construction contract, to support a Level 2 environment and the relationship with other BIM documents. Furthermore, as a relatively new contract, CPC 2013 lacks detailed review and practical exposure, so the analysis of the contract in a live environment would also be of value.

Despite this, BIM and CPC 2013 attempt to make a positive change to the construction industry, especially in relation to the proactive management of cost and time on construction projects, so they should

be commended. It is hoped that individually, or collectively, CPC 2013 and BIM can reduce the likelihood and severity of construction disputes and further research in the form of an Engineering Doctorate (EngD) is being undertaken to investigate this.

Acknowledgements

This work was supported by the Engineering and Physical Sciences Research Council (EPSRC).

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